IN THE CLAIMS:

Please add the following claims:

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7. A method for using a scanning evanescent microwave probe to determine electrical properties of a sample, said probe having a tip extending from a coaxial or transmission line resonator, comprising:

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measuring variation in resonant frequency and quality factor of said resonator resulting from interaction of said tip and said sample.

8. A method as recited in claim 7, wherein said measuring of said variation in resonant frequency and quality factor of said resonator comprises:

obtaining signals from an I/Q mixer; and

determining resonant frequency and quality factor as a function of said signals from said I/Q mixer.

9. A method as recited in claim 7, wherein said tip-sample interaction appears as equivalent complex tip-sample capacitance.

10. A method as recited in claim 9, wherein said effective complex tip-sample capacitance, $C_{tip-sample}$ is determined according to $C_{tip-sample} = C_r + C_i$ where C_r and C_i are the real and imaginary components of the tip-sample capacitance, respectively,

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$\frac{\Delta f}{f_0} = -\frac{C_r}{2C}$, $\Delta\left(\frac{1}{Q}\right) = -\left(\frac{1}{Q_0} + \frac{2C_i}{C_r}\right)\frac{\Delta f}{f_0}$, $\Delta f = f_r - f_0$, $\Delta\left(\frac{1}{Q}\right) = \frac{1}{Q} - \frac{1}{Q_0}$, and f_0 and Q_0 are the unloaded resonant frequency and quality factor, respectively.

11. A method for using a scanning evanescent microwave probe to determine electrical properties of a sample, said probe having a tip extending from a coaxial or ~~transmission line resonator, comprising:~~

38

correlating tip-sample distance, electrical impedance and their derivatives with respect to an external modulation field, with tip-sample equivalent complex capacitance.

12. A method as recited in claim 11, wherein said correlating comprises using distribution of charge or electric field with tip-sample geometry solved under a quasi-static approximation.

13. A method as recited in claim 12, wherein said quasi-static approximation is obtained by finite element analysis of electromagnetic field configuration.

14. A method as recited in claim 13, wherein said quasi-static approximation is obtained with an approximation of a metal sphere to model tip geometry.

15. A method as recited in claim 13, wherein said quasi-static approximation is obtained with an approximation of a conic section to model tip geometry.

16. A method as recited in claim 12, wherein said quasi-static approximation is obtained by an image charge method and expressed in an analytical format.

17. A method as recited in claim 16, wherein said quasi-static approximation is obtained with an approximation of a metal sphere to model tip geometry.

~~18. A method as recited in claim 16, wherein said quasi-static approximation~~ is obtained with an approximation of a conic section to model tip geometry.

19. A method as recited in claim 13, 14, 15, 16, 17 or 18, wherein said quasi-static approximation is obtained using infinite sample thickness.

20. A method as recited in claim 13, 14, 15, 16, 17 or 18, wherein said quasi-static approximation is obtained using a finite sample thickness.

21. A method as recited in claim 13, 14, 15, 16, 17 or 18, wherein said quasi-static approximation is obtained using a multi-layered sample structure.

22. A method for measuring electrical impedance of a sample using a probe having a tip, comprising:

capacitance

measuring interaction between said tip and said sample without contacting said sample with said tip; and

deriving electrical impedance from said tip-sample interaction.

23. A method as recited in claim 22, wherein said probe comprises a scanning evanescent microwave probe having a tip extending from a coaxial or transmission line resonator.

24. A method as recited in claim 22, wherein said measurements of electrical impedance are selected from the group ~~consisting essentially of quantitative and~~ qualitative measurements.

25. A method as recited in claim 22, wherein said electrical impedance comprises complex dielectric constant and conductivity of said sample.

26. A method as recited in claim 22, wherein said sample comprises a material selected from the group consisting essentially of dielectric insulators, semiconductors, metallic conductors and superconductors.

27. A method as recited in claim 22, wherein said sample comprises a multi-layered material.

28. A method as recited in claim 27, wherein said sample comprises a material selected from the group consisting essentially of dielectric insulators, semiconductors, metallic conductors and superconductors.

29. A method as recited in claim 22, wherein said tip-sample interaction is measured with a modulated external field applied to said sample.

30. A method as recited in claim 29, further comprising detecting the derivatives of the resonant frequency or phase, quality factor or amplitude of said probe with respect to said external field modulation using lock-in amplifier having an operating ~~frequency coherent with the modulating frequency~~. w/d

32

31. A method as recited in claim 22, wherein said tip-sample interaction is measured with modulation of tip-sample distance. w/d

32. A method as recited in claim 31, further comprising modulating said tip-sample distance with a piezoelectric nano-positioning device. w/d

33. A method as recited in claim 31, further comprising:

measuring said tip-sample interaction with a lock-in amplifier having an operating frequency coherent with the modulating frequency driving said nano-positioning device. w/d LAB

34. A method as recited in claim 31, further comprising:

determining a reference zero point of said tip-sample distance by the maximum amplitude of the derivative of resonant frequency or phase of said probe as said tip approaches the sample surface. w/d

35. A method as recited in claim 31, further comprising:

determining a reference zero point of said tip-sample distance by the curve fitting of the derivative of resonant frequency or phase of said probe with respect to tip-sample distance modulation as said tip approaches the sample surface.

36. A method as recited in claim 22, further comprising:

determining a physical characteristic of said sample by keeping tip-sample distance constant and calibrating with standard samples.

37. A method as recited in claim 22, further comprising:

determining a physical characteristic of said sample by keeping resonant frequency constant and calibrating with standard samples.

38. A method as recited in claim 22, further comprising:

keeping the derivative of resonant frequency with respect to tip-sample distance modulation or external field modulation constant; and

calibrating with standard samples;

wherein a physical characteristic of said sample is determined.

39. A method as recited in claim 22, further comprising:

determining a physical characteristic of said sample by curve fitting of resonant frequency or phase of said probe as said tip approaches said sample.

40. A method as recited in claim 22, further comprising:

determining a physical characteristic of said sample by curve fitting of derivatives of resonant frequency or phase of said probe with respect to external modulation field as said tip approaches said sample.

41. A method as recited in claim 22, further comprising:

determining a physical characteristic of said sample ~~by curve fitting of quality~~ factor or amplitude of said probe as said tip approaches said sample.

42. A method as recited in claim 22, further comprising:

determining a physical characteristic of said sample by curve fitting of derivatives of quality factor or amplitude of said probe with respect to external modulation field as said tip approaches said sample.

43. A method as recited in claim 29, wherein said external field comprises a bias electric field.

44. A method as recited in claim 36, 37, 38, 39, 40, 41 or 42, further comprising obtaining the nonlinear complex dielectric constant of said sample with electric field modulation.

45. A method as recited in claim 29, wherein said external field comprises a magnetic field.

46. A method as recited in claim 36, 37, 38, 39, 40, 41 or 42, further comprising obtaining a physical characteristic of said sample with magnetic field modulation.

47. A method as recited in claim 29, wherein said modulated external field comprises optical modulation.

48. A method as recited in claim 47, wherein said optical modulation is achieved by a laser having a characteristic photon energy above the semiconductor sample's carrier excitation energy.

49. A method as recited in claim 36, 37, 38, 39, 40, 41 or 42, further comprising obtaining a physical characteristic of said sample with optical modulation.

50. A method as recited in claim 49, further comprising obtaining a physical characteristic of said semiconductor selected from the group consisting essentially of photoconductivity, dopant level, junction depth, junction profile, ion implant flux level, and annealing temperature.

51. A method as recited in claim 47, wherein said optical modulation is achieved by a laser having a characteristic photon energy in infrared region; and wherein said sample is heated by said laser.

52. A method as recited in claim 36, 37, 38, 39, 40, 41 or 42, further

B2 End comprising obtaining a physical characteristic of said sample with heat modulation.

VERSION WITH MARKINGS TO SHOW CHANGES

IN THE SPECIFICATION:

Page 1, between lines 5 and 6, insert the following heading:

B3

--STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT--